

REMARKS

By this amendment, applicants have amended claim 1 to include therein the limitations previously recited in dependent claim 2. Accordingly, dependent claim 2 has been canceled. Claim 1 has also been amended to indicate that the cyclopentadienyl complex is a cyclopentadienyl ruthenium complex. See, e.g., claim 5, Figure 5 and the description thereof in applicants' specification, and, e.g., page 6, lines 11 and 12 of the substitute specification. Claim 2 has also been amended to limit the reaction gas to O<sub>2</sub>, N<sub>2</sub>O, O<sub>3</sub>, CO and CO<sub>2</sub>.

Entry of the foregoing amendment under 37 CFR 1.116 is requested. Initially, it is submitted the foregoing amendments place the application in condition for allowance for the reasons set forth hereinafter or, at least, for better form for consideration on appeal. Moreover, the amendments do not raise new issues requiring further consideration and/or search. In particular, the limitations added to claim 1 have already been considered by the Examiner in connection with dependent claims 2 and 5. Accordingly, entry of this amendment under 37 CFR 1.116 is proper.

Claims 1, 2, 5, 8, 12, 16 and 17 stand rejected under 35 USC 103(a) as being unpatentable over United States Patent No. 6,358,810 to Dornfest et al in view of United States Patent No. 5,130,172 to Hicks et al. Applicants traverse this rejection and request reconsideration thereof.

The elected invention relates to a method of manufacturing a semiconductor device having a dielectric capacitor including a bottom electrode, a dielectric layer and a top electrode on an underlying substrate having a three-dimensional structure. According to the present invention, the dielectric capacitor is provided on a substrate

that has an insulation provided thereon, the insulation layer having a hole formed therein. See, e.g., Figure 4. According to the present invention, the bottom electrode is formed on at least a side wall of the insulation layer in the hole. The dielectric layer is provided on the bottom layer and the top electrode is provided on the dielectric layer. Applicants have found that by forming the bottom electrode and the top electrode by a metalorganic chemical vapor deposition process at 180°C or higher and 250°C or lower using a cyclopentadienyl ruthenium complex as a precursor, homogenous electrode layers can be provided, even on the side wall of the insulation layer in the hole. Moreover, by using a reaction gas of O<sub>2</sub>, H<sub>2</sub>, N<sub>2</sub>O, O<sub>3</sub>, CO or CO<sub>2</sub>, the reaction can proceed at the desired temperature and the electrode can be formed with low residual carbon content. Such is neither disclosed nor suggested by Dornfest et al and Hicks et al.

The patent to Dornfest et al discloses a multi-layer semiconductor memory device comprising a bottom electrode having a bottom layer, an upper interface layer and an intermediate tuning layer disposed between the bottom layer and the upper interface layer; a top electrode; and a high dielectric constant dielectric layer disposed between the bottom electrode and the top electrode. The elected invention, however, is directed not to a semiconductor device, but to a method of manufacturing a semiconductor device, in particular, a method in which the bottom electrode and the top electrode of the dielectric capacitor are formed by a metal organic chemical vapor deposition process at 180°C or higher and 250°C or lower using a cyclopentadienyl ruthenium complex as a precursor and a reaction gas selected from the group consisting of O<sub>2</sub>, H<sub>2</sub>, N<sub>2</sub>O, O<sub>3</sub>, CO and CO<sub>2</sub>, where a volume ratio of the reaction gas to

a carrier gas is 1% or more. As admitted by the Examiner, the Dornfest et al patent does not disclose such a deposition process.

The patent to Hicks et al discloses a process for coating metal on a substrate. The process uses organometallic compounds in the presence of a reducing fluid to produce high purity films capable of selective deposition on substrates containing, for example, tungsten and silicon. The films are deposited using chemical vapor deposition or gas phase deposition. However, the Hicks et al patent also does not disclose forming the bottom electrode on at least a side wall of an insulation layer in a hole on the substrate.

In addition, while the Hicks et al patent discloses the use of various organo-metallic compounds in the presence of a reducing fluid at various temperatures, it is submitted this patent does not specifically suggest the formation of a bottom electrode and top electrode at a temperature between 180° and 250°C using a cyclopentadienyl ruthenium complex as a precursor. In fact, as can be seen from Table 1 of Hicks et al, depending on the metal to be deposited, the temperature can be below 180° (e.g. for Rh, Ir and Re) and above 250°C (i.e., for Ni and Co).

Moreover, applicants traverse the conclusion of the Examiner that the selection of the ratio of the reaction gas to carrier gas and the solubility of the precursor in the solvent is obvious because it is a matter of determining optimum process condition by routine experimentation with a limited number of species. It is submitted the Examiner has not supported this conclusion with the evidence required to support a rejection under 35 USC 103. See, In re Lee, 277 F.3d 1338, 61 USPQ 2d 1430 (Fed. Cir. 2002).

Thus, not even the combination of Dornfest et al and Hicks et al would have

suggested the method of the present invention, including forming the bottom electrode and the top electrode by a metal organic chemical vapor deposition process at 180°C or higher and 250°C or lower using a cyclopentadienyl ruthium complex as a precursor and a reaction gas selected from the group consisting of O<sub>2</sub>, H<sub>2</sub>, N<sub>2</sub>O, O<sub>3</sub>, CO and CO<sub>2</sub>, where a volume ratio of the reaction gas to a carrier gas is 1% or more.

For the foregoing reasons, the presently claimed invention is patentable over the proposed combination of Dornfest et al and Hicks et al.

Claim 15 stands rejected under 35 USC 103(a) as being unpatentable over Dornfest et al in view of Hicks et al and United States Patent No. 6,001,660 to Park et al. Applicants traverse this rejection and request reconsideration thereof.

The patent to Park et al discloses methods of forming integrated circuit capacitors using metal reflow techniques and discloses that a dielectric layer may be deposited using a sputtering method or a metal organic chemical vapor deposition (MOCVD) method. However, the Park et al patent does not remedy the deficiencies of Dornfest et al and Hicks et al in that it does not suggest forming the bottom electrode and top electrode by the metal organic chemical vapor deposition process presently recited. In fact, the Park et al patent appears to teach away from the present invention since it uses a process for forming the bottom electrode and top electrode different than that presently claimed. Accordingly, claim 15 is patentable over the proposed combination of references.

In view of the foregoing amendments and remarks, entry of this amendment and favorable reconsideration and allowance of all of the claims now in the application are requested.

To the extent necessary, applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in the fees due in connection with the filing of this paper, including extension of time fees, to the deposit account of Antonelli, Terry, Stout & Kraus, LLP, Deposit Account No. 01-2135 (Case: 501.39983X00), and please credit any excess fees to such deposit account.

Respectfully submitted,

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